531 Rec'd PCT/PTO 11 DEC 2001

BAKER BOTTS LLP TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35.U.S.C. 371		EXPRESS MAIL LABEL No EF377398406US	DATE 12/11/01
		ATTORNEY'S DOCKET NO. A34860-PCT-USA	
		U.S. APPLICATION NO. t/b/a 10/009811	
INTERNATIONAL APPLICATION NO. PCT/DE00/01847	INTERNATIONAL FILING DATE June 7, 2000	PRIORITY DATE CLAIMED June 14, 1999	

TITLE OF INVENTION VOLTAGE INTERMEDIATE CIRCUIT CONVERTER

APPLICANT(S) FOR DO/EO/US THOMAS GREIF and MATTHIAS SPITZ

Applicant herewith submits to the United States Designated /Elected Office (DO/EO/US) the following items and other information:

1. [✓] This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(I).
4. [✓] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [✓] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [✓] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [✓] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [ ] A copy of the International Search Report (PCT/ISA/210)
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [✓] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. [✓] A copy of the International Preliminary Examination Report (PCT/IPEA/409)
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [✓] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [✓] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [ ] Other items or information:
    a. [✓] a copy of the International Search Report (PCT/ISA/210)
    b. [✓] a copy of the International Preliminary Examination Report (PCT/IPEA/409)

Comparison document; English and German versions of application; cover page of PCT international application PCT/DE00/01847; formal drawings (Figs. 1-4); postcard; and check in the amount of $740.00.

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INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE00/01847	June 7, 2000	June 14, 1999

17. [ ] The following fees are submitted:

Basic National Fee (37 CFR 1.492(a)(1)-(5):

Neither international preliminary examination fee (37 CFR 1.482)

Nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO (1.492(a)(3)) $1,040

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO (1.492(a)(5) $890.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO(1.492(a)(2)) $740.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) (1.492(a)(1)) $710.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) $ 100.00

				CALCULATIONS	PTO USE ONLY
ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 740	
Surcharge of $130.00 for furnishing the oath or declaration later than **[ ] 20 [ ] 30** months from the earliest claimed priority date (37 C.F.R. 1.492)(e)).				$	
Claims	**Number Filed**	**Number Extra**	**Rate**	$	
Total Claims	6 -20=	0	X $ 18.00	$ 0	
Independent Claims	1 -3=	0	X $ 84.00	$ 0	
Multiple dependent claim(s) (if applicable)			+ $280.00	$	
TOTAL OF ABOVE CALCULATIONS =				$ 740	
Reduction by ½ for filing by small entity, if applicable.				$	
SUBTOTAL =				$ 740	
Processing fee of $130.00 for furnishing the English translation later than **[ ] 20 [ ] 30** months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 740	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$ 740	
				Amt. refunded	$
				charged	$

a. [✓] A check in the amount of $ 740.00 to cover the above fees is enclosed.

b. [ ] Please charge our Deposit Account No. 02-4377 in amount of $____ to cover the above fees. A copy of this sheet is enclosed.

c. [✓] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-4377. A copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
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New York, New York 10112-4498

Attorney: Bradley B. Geist PTO Reg: 27,551

12/11/01
Date

BAKER BOTTS LLP

Attorney Docket Number: A34860-PCT-USA

Title: VOLTAGE INTERMEDIATE CIRCUIT CONVERTER

Use Space Below for Additional Information:

10/009811

A34860-PCT-USA (071308.0283)

PATENT

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s)	:	Greif et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	VOLTAGE INTERMEDIATE CIRCUIT CONVERTER
Examiner	:	To Be Assigned
Group Art Unit	:	To Be Assigned

Assistant Commissioner for Patents
Washington, DC 20231

PRELIMINARY AMENDMENT

Sir:

Kindly amend the above-identified application before examination as follows:

IN THE SPECIFICATION:

Please substitute the originally-filed specification with the Substitute Specification which is enclosed herewith. A comparison document showing the differences between the translation of the originally-filed specification and the enclosed Substitute Specification is also enclosed herewith.

NY02:360911.1

IN THE CLAIMS:

Please amend original claims 1-6 as follows:

1. (Amended) A voltage intermediate circuit converter comprising a 12-pulse input converter having two converter elements, a voltage intermediate circuit having two capacitors connected electrically in series, and a machine-side three-point pulse-controlled converter, wherein the two converter elements are electrically conductively connected on a DC-side to a capacitor in the voltage intermediate circuit, and wherein the converter elements have a self-commutated pulse-controlled converter.

2. (Amended) The voltage intermediate circuit converter according to claim 1, wherein the self-commutated pulse-controlled converters are each three-point pulse-controlled converters.

3. (Amended) The voltage intermediate circuit converter according to claim 1, wherein each capacitor in the voltage intermediate circuit is split, with one capacitor being associated with the machine-side three-point pulse-controlled converter, and two capacitors being associated with a pulse-controlled converter in the input converter.

4. (Amended) The voltage intermediate circuit converter according to claim 1, further comprising a number of series-connected active converter devices in the self-commutated pulse-controlled converters in the input converter and a number of series-connected active converter devices in the machine-side three-point pulse-controlled converter, said number of active converter devices in the self-commutated pulse-

controlled converter being equal to the number of active converter devices in the machine-side three-point pulse-controlled converter.

5. (Amended) The voltage intermediate circuit converter according to claim 4, wherein the number of series-connected active converter devices in the self-commutated pulse-controlled converters in the input converter is one less than the number of series-connected active converter devices in the machine-side three-point pulse-controlled converter.

6. (Amended) The voltage intermediate circuit converter according to claim 4, wherein high-voltage insulated gate bipolar transistors are provided as active converter devices of the self-commutated pulse-controlled converters in the input converter and in the machine-side three-point pulse-controlled converter.

REMARKS

By this Preliminary Amendment, applicants amend originally-filed claims 1-6 to comply with the U.S. Patent and Trademark Office practice and standards. No new matter has been added to the application. Amendments to the claims do not address any issues of patentability, and the amended claims are provided to place the application in better condition for allowance.

Likewise, the amendments to the specification are provided to correct grammatical and syntactical errors in the originally filed application. No new matter has been introduced into the application.

The amendments to the "Claims" are reflected in the attached "Version With Marked Changes Made."

Favorable consideration on the merits is respectfully requested.

Respectfully submitted,

Dated: December 11, 2001

By: ______________________

Bradley B. Geist
Reg. No. 27,551

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Version With Marked Changes Made

~~We~~WE ~~Claim:~~CLAIM:

1. A voltage intermediate circuit converter ~~having~~comprising a 12-pulse input converter ~~which has~~having two converter elements, ~~having~~ a voltage intermediate circuit ~~which has~~having two capacitors ~~which are~~ connected electrically in series, and ~~having~~ a machine-side three-point pulse-controlled converter ~~(14)~~, ~~with~~wherein the two converter elements ~~of the input converter being~~are electrically conductively connected on ~~the~~a DC-side to a ~~respective~~ capacitor in the voltage intermediate circuit, ~~characterized in that~~and wherein the converter elements ~~of the input converter~~ have a ~~respective~~ self-commutated pulse-controlled converter.

2. The voltage intermediate circuit converter ~~as claimed in~~according to claim 1, ~~characterized in that~~wherein the self-commutated pulse-controlled converters are each three-point pulse-controlled converters.

3. The voltage intermediate circuit converter ~~as claimed in claims 1 and 2, characterized in that~~according to claim 1, wherein each capacitor in the voltage intermediate circuit is split ~~such that~~, with one capacitor ~~is~~being associated with the machine-side three-point pulse-controlled converter, and two capacitors ~~are~~being associated with a pulse-controlled converter in the input converter.

4. The voltage intermediate circuit converter ~~as claimed in one of the above-mentioned claims, characterized in that the~~according to claim 1, further comprising a number of series-connected active converter devices in the self-commutated pulse-controlled converters in the input converter ~~is~~and a number of series-connected active converter devices in the machine-side three-point pulse-controlled converter, said number of active converter devices in the self-commutated pulse-

controlled converter being equal to the number of ~~series-connected~~ active converter devices in the machine-side three-point pulse-controlled converter.

5. The voltage intermediate circuit converter ~~as claimed in one of claims 1 to 3, characterized in that~~according to claim 4, wherein the number of series-connected active converter devices in the self-commutated pulse-controlled converters in the input converter is one less than the number of series-connected active converter devices in the machine-side three-point pulse-controlled converter.

6. The voltage intermediate circuit converter ~~as claimed in one of the above-mentioned claims, characterized in that~~according to claim 4, wherein high-voltage insulated gate bipolar transistors are provided as active converter devices of the self-commutated pulse-controlled converters in the input converter and in the machine-side three-point pulse-controlled converter.

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TO ALL WHOM IT MAY CONCERN:

Be it known that WE, TOMAS GREIF and MATTHIAS SPITZ, citizens of Germany, whose post office addresses are Muehlleite 4, 91341 Roettenbach, Germany; and Buchleithe 53, 91086 Aurachtal, Germany; respectively, have made an invention in:

VOLTAGE INTERMEDIATE CIRCUIT CONVERTER

of which the following is a

SUBSTITUTE SPECIFICATION

FIELD OF THE INVENTION

[0001] The invention relates to a voltage intermediate circuit converter having a 12-pulse input converter, a voltage intermediate circuit and a machine converter using three-point switching.

BACKGROUND OF THE INVENTION

[0002] A converter of the type described above is disclosed in the German magazine "etz", Issue 20, 1998, pages 10 to 12. This voltage intermediate circuit converter has, in its standard version, a 12-pulse diode rectifier, wherein the diode rectifier elements are each connected to a secondary winding of a three-winding transformer. On the DC-

side, the diode rectifier elements are each linked to a capacitor in a voltage intermediate circuit, which has two capacitors which are connected electrically in series. Such an input converter is referred to as a diode front end (DFE). In most cases, such a diode front end satisfies the requirements for the mains system power factor and harmonic content. If mains feedback effects are subject to more stringent requirements, then a 24-pulse input converter is available.

[0003] A voltage intermediate circuit converter which has a self-commutated pulse-controlled converter as the input converter is described in the German magazine "Engineering and automation", Issue 1-2, 1998, pages 8 and 9. Like the machine-side pulse-controlled converter, this input converter is in the form of a three-point pulse-controlled converter. The voltage intermediate circuit is formed by two capacitors which are electrically connected in series. This input converter circuit option is also referred to as an active front end (AFE). An active front end allows four-quadrant operation (driving and regenerative braking in both rotation directions). This active input converter not only allows a power factor of $\cos \varphi = 1$ to be achieved, but also allows the wattless component of other loads to be compensated for in the mains system, at least as far as power margins are concerned. If the active front end is equipped with an input filter, virtually harmonic-free operation from the mains system is also possible.

[0004] A diode front end has the disadvantage that four-quadrant operation is not possible without further complexity. The additional complexity is that a break chopper is required for generator operation, by means of which the generated energy is converted into heat in a breaking resistance. The use of 12-pulse and 24-pulse diode front ends

means that 5th, 7th, 11th and 13th harmonics, and 5th, 7th, 13th, 23rd and 25th harmonics, respectively, are suppressed. In the 24-pulse embodiment of the diode front end, the complexity on the input side is twice that of the 12-pulse embodiment of the diode front end, which means that it is not just the space requirement that increases.

[0005] An active front end has the disadvantage that the 5th, 7th, 11th and 13th, etc. harmonics occur, depending on the number of pulses, the amplitudes of which can at least be minimized by means of an optimized pulse pattern. Furthermore, the active front end is more complex than a diode front end owing to the number and configuration of the components. Since, in design terms, the active front end corresponds to the machine-side self-commutated pulse-controlled converter, a voltage intermediate circuit converter with an active front end occupies a larger amount of space than a voltage intermediate circuit converter with a 12-pulse diode front end.

SUMMARY OF THE INVENTION

[0006] The present invention is based on the object of specifying a voltage intermediate circuit converter having an input converter designed so that the harmonics which occur on the mains system side are kept as low as possible, and with minimal complexity.

[0007] Since the converter elements of the 12-pulse input converter are each self-commutated pulse-controlled converters, the advantages of a diode front end are combined with those of an active front end. This means that the harmonic currents of the 5th, 7th, 17th and 19th harmonics are suppressed on the mains system side of the voltage intermediate circuit converter without the optimized pulse patterns of the self-commutated

pulse-controlled converters being optimized to these harmonics. Since the two converter elements are in the same operating state, their pulse patterns are the same. This optimized pulse pattern can now be optimized such that the amplitudes of the harmonic currents of the 11th, 13th, 25th, etc. harmonics are minimized.

[0008] A further advantage of this input converter according to the present invention is evident at very high voltages. The converters for standard medium voltages have two or more active converter devices connected in series for a voltage value above 3.3 kV. Since the input converter according to the invention has two identical self-commutated pulse-controlled converters, which are connected electrically in series, the number of converter elements connected in series is equal to or one less than the number of machine converters connected in series. With the standard medium voltage of 4.16 kV, the input converter of a voltage intermediate circuit converter according to the invention has precisely the same number of active converter devices as an input converter in the active front end configuration. Low blocking-capability semiconductor switches, which can be operated at a higher switching frequency or can be used at higher current levels, can be used as the active conductor devices, with precisely the same number connected in series. The design of the phase modules is both simple and space-saving, with the number of items connected in series being reduced by one.

BRIEF DESCRIPTION OF THE DRAWING

[0009] The present invention is described in greater detail in connection with the drawings which schematically show an embodiment of the input converter, and in which:

Figure 1 illustrates a block diagram of a standard version of a voltage intermediate converter;

Figure 2 illustrates a block diagram of an input converter according to the invention for a voltage intermediate circuit converter as shown in Figure 1; and

Figures 3-5 each illustrate one phase module of a machine converter of a voltage intermediate circuit converter with 1, 2 and 3 items connected in series.

DETAILED DESCRIPTION OF THE INVENTION

[0010] Figure 1 shows a block diagram of a standard version of a voltage intermediate circuit converter of a generic type with a 12-pulse input converter 2. The two converter elements 4 and 6 of this input converter 2 are each 6-pulse diode rectifiers. Each converter element 4 or 6 is linked on the DC-side to a respective capacitor 8 or 10 in a voltage intermediate circuit 12. Since these two capacitors 8 and 10 are connected electrically in series, this voltage intermediate circuit 12 has three potentials C, M and D. Furthermore, this voltage intermediate circuit converter has a machine converter 14 with the AC-side outputs R, S, T being connected to a three-phase machine 16. On the DC-side, the machine converter 14 is electrically conductively connected to the three potentials C, M and D of the voltage intermediate circuit 12. High-voltage insulated gate bipolar transistors (HV-IGBTs) are provided as active converter devices for the machine converter 14. The machine converter 14 uses three-point switching. The converter elements 4 and 6 of the input converter 2 are electrically conductively connected on the AC-side to a secondary winding 18 or 20 of a three-winding transformer 22. On the primary side, this three-winding transformer 22 is linked to a three-phase mains system 24.

[0011] Figure 2 shows a block diagram of an embodiment of the input converter 2 of the present invention. This input converter 2 has respective self-commutated pulse-controlled converters 4_1 and 6_1 as the converter elements 4 and 6, respectively. These two pulse-controlled converters 4_1 and 6_1 use three-point switching in the same way as the machine-side three-point pulse-controlled converter 14, with HV-IGBTs likewise being used as the active converter devices. On the AC-side, the connections U1, V1, W1 of the self-commutated pulse-controlled converter 4_1 are linked to the secondary winding 18 of the three-winding transformer 22. On the AC-side, the connections U2, V2, W2 of the self-commutated pulse-controlled converter 6_1 are connected to the secondary winding 20 of the three-winding transformer 22.

[0012] Figure 2 also shows the voltage intermediate circuit 12 in more detail. The two capacitors 8 and 10 of this voltage intermediate circuit 12 are each subdivided into three capacitor elements 8_1, 8_2, 8_3 and 10_1, 10_2, 10_3. In this case, the two capacitor elements 8_2, 8_3 and 10_2, 10_3 are connected electrically in series, and this series circuit is then connected electrically in parallel with the respective capacitors 8_1 and 10_1. The junction point between the two series-connected capacitors 8_2, 8_3 and 10_2, 10_3 form a medium-voltage potential M1 or M2, respectively, for the respective three-point pulse-controlled converters 4_1 and 6_1. These two series circuits of capacitor elements 8_2, 8_3 and 10_2, 10_3 are also connected electrically in series. The junction point between these two series circuits is connected to the central voltage M of the voltage intermediate circuit 12. Since the capacitors 8 and 10 in the voltage intermediate circuit 12 are each subdivided into a number of capacitor elements 8_1, 8_2, 8_3 and 10_1, 10_2, 10_3, the capacitor elements 8_1

and 10_1 can be physically associated with the machine converter 14, and the capacitor elements 8_2, 8_3 and 10_2, 10_3 can be physically associated with the self-commutated pulse-controlled converter 4_1, 6_1 in the input converter 2.

[0013] Figure 3 shows a phase module of the machine converter 14, which has four active converter devices T1, T2, T3 and T4 using three-point switching. Each active converter device T1 to T4 has only one semiconductor switch, in particular an HV-IGBT. The number of series connected items in this embodiment is therefore one. This phase module can accommodate a maximum DC voltage U_{ZK} of 3.8 kV between its DC potentials C and D. This DC voltage U_{ZK} is produced by the input converter 2. Since the two converter elements 4_1 and 6_1 are identical and are connected electrically in series on the DC-side, each converter element 4_1 and 6_1 produces half the intermediate circuit voltage U_{ZK}, amounting to 1.9 kV. However, since the phase module has twice the withstand voltage, low blocking-capability semiconductor switches can be used, in comparison to the phase module of the machine-side three-point pulse-controlled converter 14. These low blocking-capability HV-IGBTs can be operated at a higher switching frequency, or at a higher current level.

[0014] Figure 4 shows a phase module, whose active converter devices T1 and T4 each have two semiconductor switches, in particular HV-IGBTs. In this case, the number of items connected in series is two (2). A maximum DC voltage U_{ZK} of 6.8 kV can occur between the DC potentials C and D. In a voltage intermediate circuit converter as shown in Figure 1, and having an input converter 2 according to the invention, the phase modules of the machine-side three-point pulse-controlled converter 14 are designed as shown in

Figure 4, and the phase modules of the converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 3.

[0015] Figure 5 shows a phase module in which the active converter devices T1 to T4 each have three semiconductor switches, in particular HV-IGBTs. The number of these active converter devices connected in series is three. In this phase module, with three items connected in series, it is possible for a maximum DC voltage U_{ZK} of 10 kW to be dropped between or across the potentials C and D. In a voltage intermediate circuit converter for a standard medium voltage of 6 kV, the phase modules of the machine converter 14 are designed as shown in Figure 5, and the phase modules of the converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 4.

[0016] The number of items connected in series in the converter elements 4_1 and 6_1 in comparison to the number of items connected in series in the machine converter 14 is thus one less beyond a standard medium voltage of 3.3 kV. The phase modules of the converter elements 4_1 and 6_1 are therefore less complex than the phase modules in the machine converter 14. In a voltage intermediate circuit converter for the medium voltage of 4.16 kV, the number of semiconductor switches in the two converter elements 4_1 and 6_1 in the input converter 2 is equal to the number of semiconductor switches in the input converter 2 in the active front end embodiment. This means that, 5th, 7th, 17th and 19th harmonics are eliminated just by the circuitry, and without having to increase the number of semiconductor switches.

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VOLTAGE INTERMEDIATE CIRCUIT CONVERTER

of which the following is a

SPECIFICATION

~~BACKGROUND OF THE INVENTION~~

FIELD OF THE INVENTION

[0001] The invention relates to a voltage intermediate circuit converter ~~as claimed in the precharacterizing clause of claim 1.~~having a 12-pulse input converter, ~~for~~ a voltage intermediate circuit ~~converter~~and a machine converter using three-point switching.

BACKGROUND OF THE INVENTION

[0002] A converter ~~such as this is known from~~of the type described above is disclosed in the German magazine "etz", Issue 20, 1998, pages 10 to 12. This ~~known~~ voltage

intermediate circuit converter has, in ~~the~~its standard version, a 12-pulse diode rectifier, ~~whose~~wherein the diode rectifier elements are each connected to a secondary winding of a three-winding transformer. On the DC-side, the diode rectifier elements are each linked to a capacitor in a voltage intermediate circuit, which has two capacitors which are connected electrically in series. Such an input converter is ~~also~~ referred to as a diode front end (DFE). In most cases, such a diode front end satisfies the requirements for the mains system power factor and harmonic content. If mains feedback effects are subject to more stringent requirements, then a 24-pulse input converter is available.

[0003] A voltage intermediate circuit converter which has a self-commutated pulse-controlled converter as the input converter is ~~known from~~described in the German magazine "Engineering and automation", Issue 1-2, 1998, pages 8 and 9. Like the machine-side pulse-controlled converter, this input converter is in the form of a three-point pulse-controlled converter. The voltage intermediate circuit is formed by two capacitors which are electrically connected in series. This input converter circuit option is also referred to as an active front end (AFE). An active front end allows four-quadrant operation (driving and regenerative braking in both rotation directions). This active input converter not only allows a power factor of cos $\varphi = 1$ to be achieved, but also allows the wattless component of other loads to be compensated for in the mains system, at least as far as power margins are concerned. If the active front end is equipped with an input filter, virtually harmonic-free operation from the mains system is also possible.

[0004] A diode front end has the disadvantage that four-quadrant operation is not possible without further complexity. The additional complexity is that a break chopper is required

for generator operation, by means of which the generated energy is converted into heat in a breaking resistance. The use of 12-pulse and 24-pulse diode front ends means that 5th, 7th, 11th and 13th harmonics, and 5th, 7th, 13th, 23rd and 25th harmonics, respectively, are suppressed. In the 24-pulse embodiment of the diode front end, the complexity on the input side is twice that of the 12-pulse embodiment of the diode front end, which means that it is not just the space requirement that increases.

[0005] An active front end has the disadvantage that the 5th, 7th, 11th and 13th, etc. harmonics occur, depending on the number of pulses, ~~whose~~the amplitudes~~,~~ of which can at least be minimized by means of an optimized pulse pattern. Furthermore, the active front end is more complex than a diode front end owing to the number and configuration of the components. Since, in design terms, the active front end corresponds to the machine-side self-commutated pulse-controlled converter, a voltage intermediate circuit converter with an active front end occupies a larger amount of space than a voltage intermediate circuit converter with a 12-pulse diode front end.

SUMMARY OF THE INVENTION

[0006] The present invention is~~ now~~ based on the object of specifying a voltage intermediate circuit converter ~~whose~~having an input converter~~ is~~ designed ~~such~~so that the harmonics which occur on the mains system side are kept as low as possible, and with ~~little~~minimal complexity.

~~**[0007]** This object is achieved according to the invention by the characterizing features of claim 1.~~

[0007] ~~[0008]~~ Since the converter elements of the 12-pulse input converter are each self-commutated pulse-controlled converters, the advantages of a diode front end are combined with those of an active front end. This means that the harmonic currents of the 5th, 7th, 17th and 19th harmonics are suppressed on the mains system side of the voltage intermediate circuit converter without the optimized pulse patterns of the self-commutated pulse-controlled converters being optimized to these ~~said~~ harmonics. Since the two converter elements are in the same operating state, their pulse patterns are the same. This optimized pulse pattern can now be optimized such that the amplitudes of the harmonic currents of the 11th, 13th, 25th, etc. harmonics are minimized.

[0008] ~~[0009]~~ A further advantage of this input converter according to the present invention ~~for a voltage intermediate circuit converter~~ is evident at very high voltages. The converters for standard medium voltages have two or more active converter devices connected in series for a voltage value above 3.3 kV. Since the input converter according to the invention has two identical self-commutated pulse-controlled converters, which are connected electrically in series, the number of converter elements connected in series is equal to or one less than the number of machine converters connected in series. With the standard medium voltage of 4.16 kV, the input converter of a voltage intermediate circuit converter according to the invention has precisely the same number of active converter devices as an input converter in the active front end configuration. Low blocking-capability semiconductor switches, which can be operated at a higher switching frequency or can be used at higher current levels, can be used as the active conductor devices, with precisely the same number connected in series. The design of the phase modules is

~~simpler~~both simple and ~~more~~ space-saving, with the number of items connected in series being reduced by one.

~~[0010] Advantageous embodiments of the input converter can be found in the dependent claims 2 to 6.~~

BRIEF DESCRIPTION OF THE DRAWING

[0009] ~~[0011] In order to explain the~~The present invention is described in ~~more~~greater detail~~, reference should be made to~~ in connection with the ~~drawing,~~drawings which ~~shows one~~schematically show an embodiment of the input converter ~~according to the invention, schematically~~, and in which:

Figure 1 ~~shows~~illustrates a block diagram of a standard version of a voltage intermediate converter ~~of this generic type~~;

Figure 2 ~~shows~~illustrates a block diagram of an input converter according to the invention for a voltage intermediate circuit converter as shown in Figure 1; and

Figures 3-5 each ~~show~~illustrate one phase module of a machine converter of a voltage intermediate circuit converter with 1, 2 and 3 items connected in series.

DETAILED DESCRIPTION OF THE INVENTION

[0010] ~~[0012]~~ Figure 1 shows a block diagram of a standard version of a voltage intermediate circuit converter of ~~this~~a generic type with a 12-pulse input converter 2. The two converter elements 4 and 6 of this input converter 2 are each 6-pulse diode rectifiers. Each converter element 4 or 6 is linked on the DC-side to a respective capacitor 8 or 10 in a voltage intermediate circuit 12. Since these two capacitors 8 and 10 are connected

electrically in series, this voltage intermediate circuit 12 has three potentials C, M and D. Furthermore, this voltage intermediate circuit converter has a machine converter ~~14, to whose~~14 with the AC-side outputs R, S, T being connected to a three-phase machine ~~16 is connected.~~16. On the DC-side, ~~this~~the machine converter 14 is electrically conductively connected to the three potentials C, M and D of the voltage intermediate circuit 12. High-voltage insulated gate bipolar transistors (HV-IGBTs) are provided as active converter devices for the machine converter 14. The machine converter 14 uses three-point switching. The converter elements 4 and 6 of the input converter 2 are electrically conductively connected on the AC-side to a ~~respective~~ secondary winding 18 or 20 of a three-winding transformer 22. On the primary side, this three-winding transformer 22 is linked to a three-phase mains system 24.

[0011] ~~[0013]~~ Figure 2 shows a block diagram of an ~~advantageous~~ embodiment~~,~~ ~~according to~~ of the input converter 2 of the present invention~~, of an input converter 2.~~. This input converter 2 has respective self-commutated pulse-controlled converters 4_1 and 6_1 as the converter elements 4 and 6, respectively. These two pulse-controlled converters 4_1 and 6_1 use three-point switching in the same way as the machine-side three-point pulse-controlled converter 14, with HV-IGBTs likewise being used as the active converter devices. On the AC-side, the connections U1, V1, W1 of the self-commutated pulse-controlled converter 4_1 are linked to the secondary winding 18 of the three-winding transformer 22. On the AC-side, the connections U2, V2, W2 of the self-commutated pulse-controlled converter 6_1 are connected to the secondary winding 20 of the three-winding transformer 22.

[0012] ~~[0014] This illustration in~~ Figure 2 also shows the voltage intermediate circuit 12 in more detail. The two capacitors 8 and 10 of this voltage intermediate circuit 12 are each subdivided into three capacitor elements 8_1, 8_2, 8_3 and 10_1, 10_2, 10_3. In this case, the two capacitor elements 8_2, 8_3 and 10_2, 10_3 are connected electrically in series, and this series circuit is then connected electrically in parallel with the respective capacitors 8_1 and 10_1. The junction point between the two series-connected capacitors 8_2, 8_3 and 10_2, 10_3 form a medium-voltage potential M1 or M2, respectively, for the respective three-point pulse-controlled converters 4_1 and 6_1. These two series circuits of capacitor elements 8_2, 8_3 and 10_2, 10_3 are also connected electrically in series. The junction point between these two series circuits is connected to the central voltage M of the voltage intermediate circuit 12. Since the capacitors 8 and 10 in the voltage intermediate circuit 12 are each subdivided into a number of capacitor elements 8_1, 8_2, 8_3 and 10_1, 10_2, 10_3, the capacitor elements 8_1 and 10_1 can be physically associated with the machine converter 14, and the capacitor elements 8_2, 8_3 and 10_2, 10_3 can be physically associated with the self-commutated pulse-controlled converter 4_1, 6_1 in the input converter 2.

[0013] ~~[0015]~~ Figure 3 shows a phase module of the machine converter 14, which has four active converter devices T1, T2, T3 and T4 using three-point switching. Each active converter device T1 to T4 has only one semiconductor switch, in particular an HV-IGBT. The number of series connected items in this embodiment is therefore one. This phase module can accommodate a maximum DC voltage U_{ZK} of 3.8 kV between its DC potentials C and D. This DC voltage U_{ZK} is produced by the input converter 2. Since the

two converter elements 4_1 and 6_1 are identical and are connected electrically in series on the DC-side, each converter element 4_1 and 6_1 produces half the intermediate circuit voltage U_{ZK}, amounting to 1.9 kV. However, since the phase module has twice the withstand voltage, low blocking-capability semiconductor switches can be used, in comparison to the phase module of the machine-side three-point pulse-controlled converter 14. These low blocking-capability HV-IGBTs can be operated at a higher switching frequency, or at a higher current level.

[0014] ~~[0016]~~ Figure 4 shows a phase module, whose active converter devices T1 and T4 each have two semiconductor switches, in particular HV-IGBTs. In this case, the number of items connected in series is ~~2.~~two (2). A maximum DC voltage U_{ZK} of 6.8 kV can occur between the DC potentials C and D. In a voltage intermediate circuit converter as shown in Figure 1, and having an input converter 2 according to the invention, the phase modules of the machine-side three-point pulse-controlled converter 14 are designed as shown in Figure 4, and the phase modules of the converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 3.

[0015] ~~[0017]~~ Figure 5 shows a phase module ~~whose~~in which the active converter devices T1 to T4 each have three semiconductor switches, in particular HV-IGBTs. The number of these active converter devices connected in series is three. ~~With~~In this phase module, with three items connected in series, it is possible for a maximum DC voltage U_{ZK} of 10 kW to be dropped between or across the potentials C and D. In a voltage intermediate circuit converter for a standard medium voltage of 6 kV, the phase modules of the machine converter 14 are designed as shown in Figure 5, and the phase modules of

the converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 4.

[0016] ~~[0018]~~ The number of items connected in series in the converter elements 4_1 and 6_1 in comparison to the number of items connected in series in the machine converter 14 is thus one less beyond a standard medium voltage of 3.3 kV. The phase modules of the converter elements 4_1 and 6_1 are therefore less complex than the phase modules in the machine converter 14. In a voltage intermediate circuit converter for the medium voltage of 4.16 kV, the number of semiconductor switches in the two converter elements 4_1 and 6_1 in the input converter 2 is equal to the number of semiconductor switches in the input converter 2 in the active front end embodiment. This means that, 5th, 7th, 17th and 19th harmonics are eliminated just by the circuitry, and without having to increase the number of semiconductor switches.

~~We~~WE ~~Claim:~~CLAIM:

1. A voltage intermediate circuit converter ~~having~~comprising a 12-pulse input converter ~~which has~~having two converter elements~~, having~~ a voltage intermediate circuit ~~which has~~having two capacitors ~~which are~~ connected electrically in series, and ~~having~~ a machine-side three-point pulse-controlled converter ~~(14)~~, ~~with~~wherein the two converter elements ~~of the input converter being~~are electrically conductively connected on ~~the~~a DC-side to a ~~respective~~ capacitor in the voltage intermediate circuit, ~~characterized in that~~and wherein the converter elements ~~of the input converter~~ have a ~~respective~~ self-commutated pulse-controlled converter.

2. The voltage intermediate circuit converter ~~as claimed in~~according to claim 1, ~~characterized in that~~wherein the self-commutated pulse-controlled converters are each three-point pulse-controlled converters.

3. The voltage intermediate circuit converter ~~as claimed in claims 1 and 2, characterized in that~~according to claim 1, wherein each capacitor in the voltage intermediate circuit is split ~~such that~~, with one capacitor ~~is~~being associated with the machine-side three-point pulse-controlled converter, and two capacitors ~~are~~being associated with a pulse-controlled converter in the input converter.

4. The voltage intermediate circuit converter ~~as claimed in one of the above-mentioned claims, characterized in that the~~according to claim 1, further comprising a number of series-connected active converter devices in the self-commutated pulse-controlled converters in the input converter ~~is~~and a number of series-connected active

converter devices in the machine-side three-point pulse-controlled converter, said number of active converter devices in the self-commutated pulse-controlled converter being equal to the number of ~~series-connected~~ active converter devices in the machine-side three-point pulse-controlled converter.

5. The voltage intermediate circuit converter ~~as claimed in one of claims 1 to 3, characterized in that~~according to claim 4, wherein the number of series-connected active converter devices in the self-commutated pulse-controlled converters in the input converter is one less than the number of series-connected active converter devices in the machine-side three-point pulse-controlled converter.

6. The voltage intermediate circuit converter ~~as claimed in one of the above-mentioned claims, characterized in that~~according to claim 4, wherein high-voltage insulated gate bipolar transistors are provided as active converter devices of the self-commutated pulse-controlled converters in the input converter and in the machine-side three-point pulse-controlled converter.

ABSTRACT

The invention relates to a voltage intermediate circuit converter having a 12-pulse input converter, having a voltage intermediate circuit and having a machine converter using three-point switching. According to the invention, the two converter elements of the input converter have a respective self-commutated pulse-controlled converter. An input converter is thus obtained, which links the advantages of a diode front end and an active front end with one another.

10/009811
531 Rec'd PCT/PTC 11 DEC 2001

Description

Voltage intermediate circuit converter

The invention relates to a voltage intermediate circuit converter as claimed in the precharacterizing clause of claim 1.

A converter such as this is known from German magazine "etz", Issue 20, 1998, pages 10 to 12. This known voltage intermediate circuit converter has, in the standard version, a 12-pulse diode rectifier, whose diode rectifier elements are each connected to a secondary winding of a three-winding transformer. On the DC-side, the diode rectifier elements are each linked to a capacitor in a voltage intermediate circuit, which has two capacitors which are connected electrically in series. Such an input converter is also referred to as a diode front end (DFE). In most cases, such a diode front end satisfies the requirements for the mains system power factor and harmonic content. If mains feedback effects are subject to more stringent requirements, then a 24-pulse input converter is available.

A voltage intermediate circuit converter which has a self-commutated pulse-controlled converter as the input converter is known from German magazine "Engineering and automation", Issue 1-2, 1998, pages 8 and 9. Like the machine-side pulse-controlled converter, this is in the form of a three-point pulse-controlled converter. The voltage intermediate circuit is formed by two capacitors which are electrically connected in series. This input converter circuit option is also referred to as an active front end (AFE). An active front end allows four-quadrant

operation (driving and regenerative braking in both rotation directions). This

active input converter not only allows a power factor of $\cos \varphi = 1$ to be achieved,but also allows the wattless component

of other loads to be compensated for in the mains system, at least as far as power margins are concerned. If the active front end is equipped with an input filter, virtually harmonic-free operation from the mains system is also possible.

A diode front end has the disadvantage that four-quadrant operation is not possible without further complexity. The additional complexity is that a break chopper is required for generator operation, by means of which the generated energy is converted into heat in a breaking resistance. The use of 12-pulse and 24-pulse diode front ends means that 5th, 7th, 11th and 13th harmonics, and 5th, 7th, 13th, 23rd and 25th harmonics, respectively, are suppressed. In the 24-pulse embodiment of the diode front end, the complexity on the input side is twice that of the 12-pulse embodiment of the diode front end, which means that it is not just the space requirement that increases.

An active front end has the disadvantage that the 5th, 7th, 11th and 13th, etc. harmonics occur, depending on the number of pulses, whose amplitudes, can at least be minimized by means of an optimized pulse pattern. Furthermore, the active front end is more complex than a diode front end owing to the number and configuration of the components. Since, in design terms, the active front end corresponds to the machine-side self-commutated pulse-controlled converter, a voltage intermediate circuit converter with an active front end occupies a larger amount of space than a voltage intermediate circuit converter with a 12-pulse diode front end.

The invention is now based on the object of specifying a voltage intermediate circuit converter whose input

converter is designed such that the harmonics which occur on the mains system side are kept as low as possible, with little complexity.

This object is achieved according to the invention by the characterizing features of claim 1.

Since the converter elements of the 12-pulse input converter are each self-commutated pulse-controlled converters, the advantages of a diode front end are combined with those of an active front end. This means that the harmonic currents of the 5th, 7th, 17th and 19th harmonics are suppressed on the mains system side of the voltage intermediate circuit converter without the optimized pulse patterns of the self-commutated pulse-controlled converters being optimized to these said harmonics. Since the two converter elements are in the same operating state, their pulse patterns are the same. This optimized pulse pattern can now be optimized such that the amplitudes of the harmonic currents of the 11th, 13th, 25th, etc. harmonics are minimized.

A further advantage of this input converter according to the invention for a voltage intermediate circuit converter is evident at very high voltages. The converters for standard medium voltages have two or more active converter devices connected in series for a voltage value above 3.3 kV. Since the input converter according to the invention has two identical self-commutated pulse-controlled converters, which are connected electrically in series, the number of converter elements connected in series is equal to or one less than the number of machine converters connected in series. With the standard medium voltage of 4.16 kV, the input converter of a voltage intermediate circuit converter according to the invention has precisely the same number of active converter devices as an input converter in the active front end configuration. Low blocking-capability semiconductor switches, which can be operated at a higher

switching frequency or can be used at higher current levels, can be used as the active conductor

devices, with precisely the same number connected in series. The design of the phase modules is simpler and more space-saving, with the number of items connected in series being reduced by one.

Advantageous embodiments of the input converter can be found in the dependent claims 2 to 6.

In order to explain the invention in more detail, reference should be made to the drawing, which shows one embodiment of the input converter according to the invention, schematically, and in which:

Figure 1 shows a block diagram of a standard version of a voltage intermediate converter of this generic type,

Figure 2 shows a block diagram of an input converter according to the invention for a voltage intermediate circuit converter as shown in Figure 1, and

Figures 3-5 each show one phase module of a machine converter of a voltage intermediate circuit converter with 1, 2 and 3 items connected in series.

Figure 1 shows a block diagram of a standard version of a voltage intermediate circuit converter of this generic type with a 12-pulse input converter 2. The two converter elements 4 and 6 of this input converter 2 are each 6-pulse diode rectifiers. Each converter element 4 or 6 is linked on the DC-side to a respective capacitor 8 or 10 in a voltage intermediate circuit 12. Since these two capacitors 8 and 10 are connected electrically in series, this voltage intermediate circuit 12 has three potentials C, M and D. Furthermore, this voltage intermediate circuit converter has a machine converter 14, to whose AC-side outputs R, S, T a three-phase machine 16 is connected. On the DC-side, this machine converter 14 is

electrically conductively connected to the three potentials C, M and D of the voltage intermediate

circuit 12. High-voltage insulated gate bipolar transistors (HV-IGBTs) are provided as active converter devices for the machine converter 14. The machine converter 14 uses three-point switching. The converter elements 4 and 6 of the input converter 2 are

electrically conductively connected on the AC-side to a respective secondary winding 18 or 20 of a three-winding transformer 22. On the primary side, this three-winding transformer 22 is linked to a three-phase mains system 24.

Figure 2 shows a block diagram of an advantageous embodiment, according to the invention, of an input converter 2. This input converter 2 has respective self-commutated pulse-controlled converters 4_1 and 6_1 as the converter elements 4 and 6, respectively. These two pulse-controlled converters 4_1 and 6_1 use three-point switching in the same way as the machine-side three-point pulse-controlled converter 14, with HV-IGBTs likewise being used as the active converter devices. On the AC-side, the connections U1, V1, W1 of the self-commutated pulse-controlled converter 4_1 are linked to the secondary winding 18 of the three-winding transformer 22. On the AC-side, the connections U2, V2, W2 of the self-commutated pulse-controlled converter 6_1 are connected to the secondary winding 20 of the three-winding transformer 22.

This illustration in Figure 2 also shows the voltage intermediate circuit 12 in more detail. The two capacitors 8 and 10 of this voltage intermediate circuit 12 are each subdivided into three capacitor elements 8_1, 8_2, 8_3 and 10_1, 10_2, 10_3. In this case, the two capacitor elements 8_2, 8_3 and 10_2, 10_3 are connected electrically in series, and this series circuit is then connected electrically in parallel with the respective capacitors 8_1 and 10_1. The junction point between the two series-connected capacitors 8_2, 8_3 and 10_2, 10_3 form a medium-voltage potential M1 or M2, respectively, for the respective three-point pulse-controlled converters 4_1 and

6_1. These two series circuits of capacitor elements 8_2, 8_3 and 10_2, 10_3 are also connected electrically in series. The junction point between

these two series circuits is connected to the central voltage M of the voltage intermediate circuit 12. Since the capacitors 8and 10 in the voltage intermediate circuit 12 are each subdivided into a number of capacitor elements 8_1, 8_2, 8_3 and 10_1, 10_2, 10_3,

the capacitor elements 8_1 and 10_1 can be physically associated with the machine converter 14, and the capacitor elements 8_2, 8_3 and 10_2, 10_3 can be physically associated with the self-commutated pulse-controlled converter 4_1, 6_1 in the input converter 2.

Figure 3 shows a phase module of the machine converter 14, which has four active converter devices T1, T2, T3 and T4 using three-point switching. Each active converter device T1 to T4 has only one semiconductor switch, in particular an HV-IGBT. The number of series connected items in this embodiment is therefore one. This phase module can accommodate a maximum DC voltage U_{ZK} of 3.8 kV between its DC potentials C and D. This DC voltage U_{ZK} is produced by the input converter 2. Since the two converter elements 4_1 and 6_1 are identical and are connected electrically in series on the DC-side, each converter element 4_1 and 6_1 produces half the intermediate circuit voltage U_{ZK}, amounting to 1.9 kV. However, since the phase module has twice the withstand voltage, low blocking-capability semiconductor switches can be used, in comparison to the phase module of the machine-side three-point pulse-controlled converter 14. These low blocking-capability HV-IGBTs can be operated at a higher switching frequency, or at a higher current level.

Figure 4 shows a phase module, whose active converter devices T1 and T4 each have two semiconductor switches, in particular HV-IGBTs. In this case, the number of items connected in series is 2. A maximum DC voltage U_{ZK} of 6.8 kV can occur between the DC potentials C and D. In a voltage intermediate circuit converter as shown in Figure 1, having an input converter 2 according to the invention, the phase modules of the machine-side three-

point pulse-controlled converter 14 are designed as shown in Figure 4, and the phase modules of the

converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 3.

Figure 5 shows a phase module whose active converter devices T1 to T4 each have three semiconductor switches,

in particular HV-IGBTs. The number of these active converter devices connected in series is three. With this phase module, with three items connected in series, it is possible for a maximum DC voltage U_{ZK} of 10 kW to be dropped between or across the potentials C and D. In a voltage intermediate circuit converter for a standard medium voltage of 6 kV, the phase modules of the machine converter 14 are designed as shown in Figure 5, and the phase modules of the converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 4.

The number of items connected in series in the converter elements 4_1 and 6_1 in comparison to the number of items connected in series in the machine converter 14 is thus one less beyond a standard medium voltage of 3.3 kV. The phase modules of the converter elements 4_1 and 6_1 are therefore less complex than the phase modules in the machine converter 14. In a voltage intermediate circuit converter for the medium voltage of 4.16 kV, the number of semiconductor switches in the two converter elements 4_1 and 6_1 in the input converter 2 is equal to the number of semiconductor switches in the input converter 2 in the active front end embodiment. This means that, 5th, 7th, 17th and 19th harmonics are eliminated just by the circuitry, without having to increase the number of semiconductor switches.

Patent Claims

1. A voltage intermediate circuit converter having a 12-pulse input converter (2) which has two converter elements (4, 6), having a voltage intermediate circuit (12) which has two capacitors (8, 10) which are connected electrically in series, and having a machine-side three-point pulse-controlled converter (14), with the two converter elements (4, 6) of the input converter (12) being electrically conductively connected on the DC-side to a respective capacitor (8, 10) in the voltage intermediate circuit (12), characterized in that the converter elements (4, 6) of the input converter (12) have a respective self-commutated pulse-controlled converter (4_1, 6_1).

2. The voltage intermediate circuit converter as claimed in claim 1, characterized in that the self-commutated pulse-controlled converters (4_1, 6_1) are each three-point pulse-controlled converters.

3. The voltage intermediate circuit converter as claimed in claims 1 and 2, characterized in that each capacitor (8, 10) in the voltage intermediate circuit (12) is split such that one capacitor (8_1, 10_1) is associated with the machine-side three-point pulse-controlled converter (14), and two capacitors (8_2, 8_3; 10_2, 10_3) are associated with a pulse-controlled converter (4_1, 6_1) in the input converter (12).

4. The voltage intermediate circuit converter as claimed in one of the abovementioned claims,

characterized in that the number of series-connected active converter devices (T1, T2, T3, T4) in the self-commutated pulse-controlled converters (4_1, 6_1) in the input converter (12) is equal to the number of series-connected active converter devices (T1, T2, T3, T4) in the machine-side three-point pulse-controlled converter (14).

5. The voltage intermediate circuit converter as claimed in one of claims 1 to 3, characterized in that the number of series-connected active converter devices (T1, T2, T3, T4) in the self-commutated pulse-controlled converters (4_1, 6_1) in the input converter (12) is one less than the number of series-connected active converter devices (T1, T2, T3, T4) in the machine-side three-point pulse-controlled converter (14).

6. The voltage intermediate circuit converter as claimed in one of the abovementioned claims, characterized in that high-voltage insulated gate bipolar transistors are provided as active converter devices (T1, T2, T2, T4) of the self-commutated pulse-controlled converters (4_1, 6_1) in the input converter (12) and in the machine-side three-point pulse-controlled converter (14).

Abstract

Voltage intermediate circuit converter

The invention relates to a voltage intermediate circuit converter having a 12-pulse input converter (2), having a voltage intermediate circuit (12) and having a machine converter (14) using three-point switching. According to the invention, the two converter elements (4, 6) of the input converter (2) have a respective self-commutated pulse-controlled converter (4_1, 6_1). An input converter (2) is thus obtained, which links the advantages of a diode front end and an active front end with one another.

FIG 2

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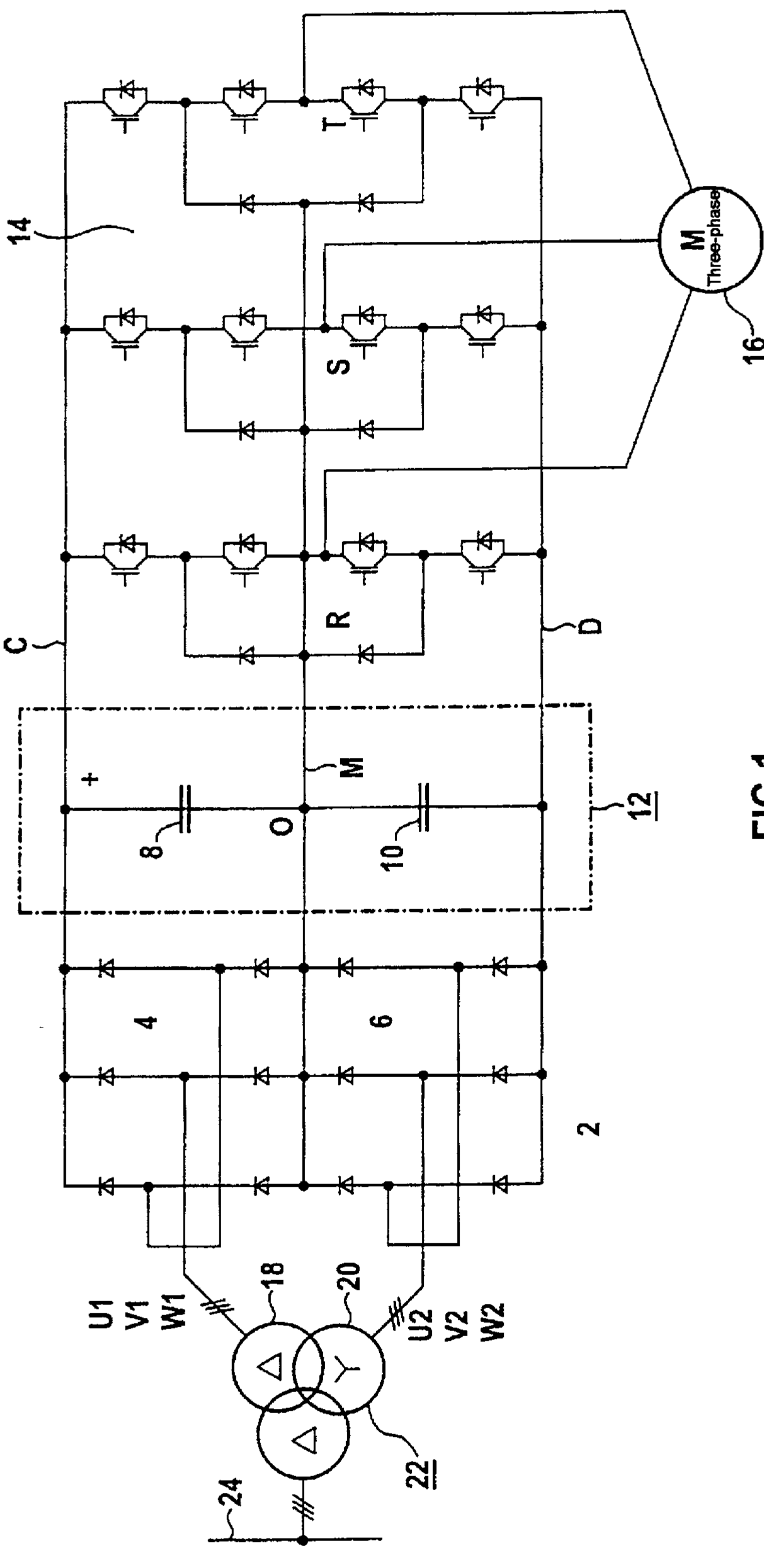

FIG 1

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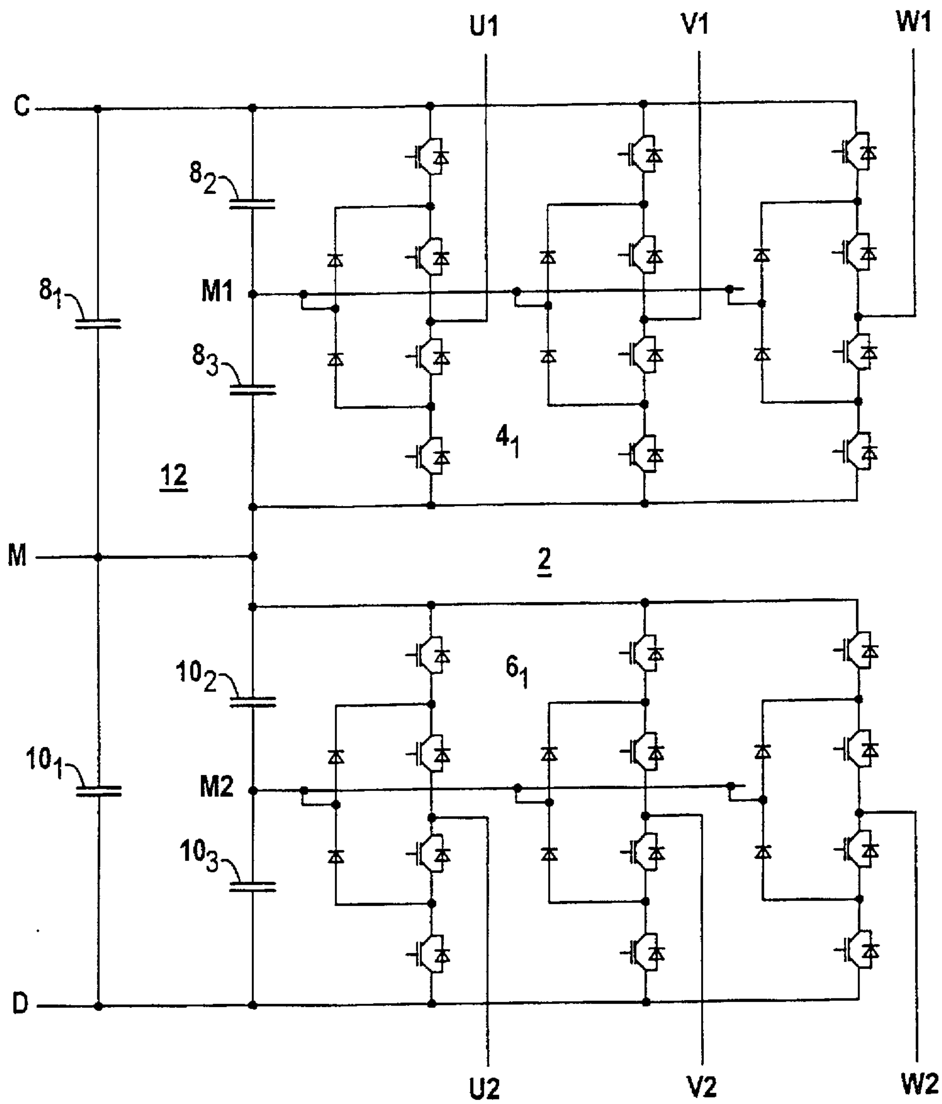

FIG 2

99 P 3399

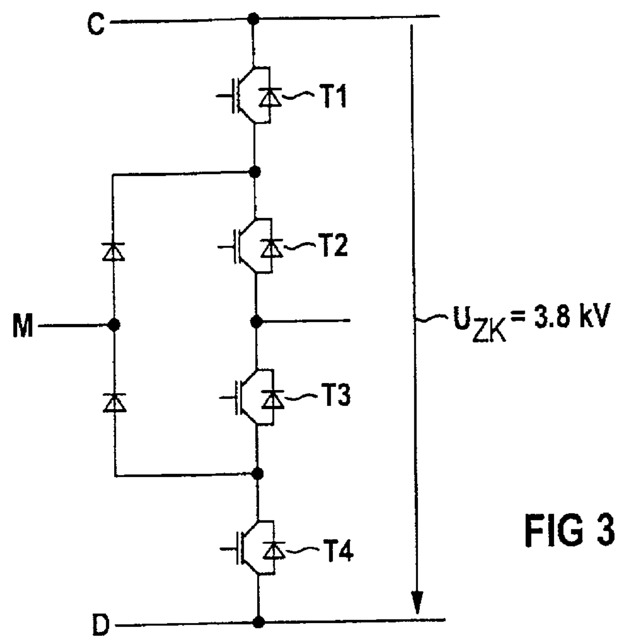

FIG 3

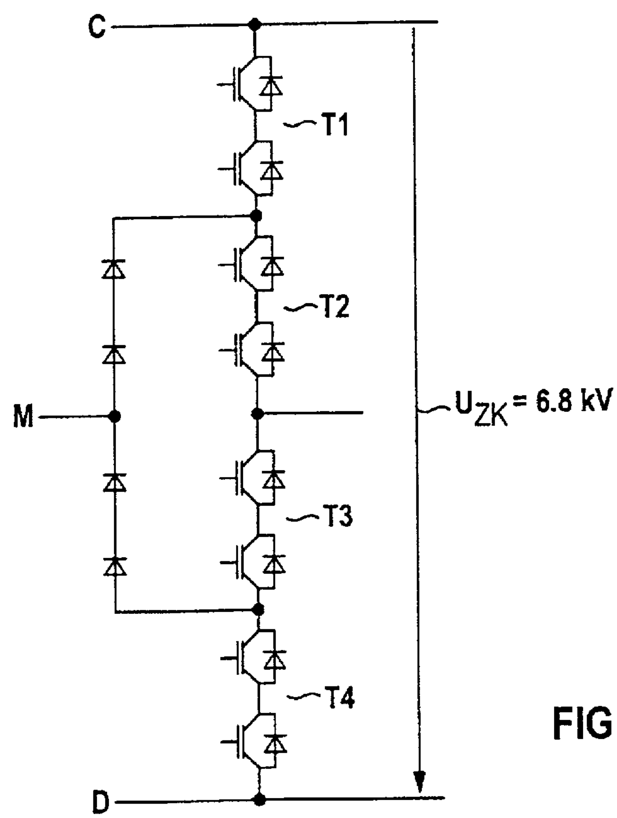

FIG 4

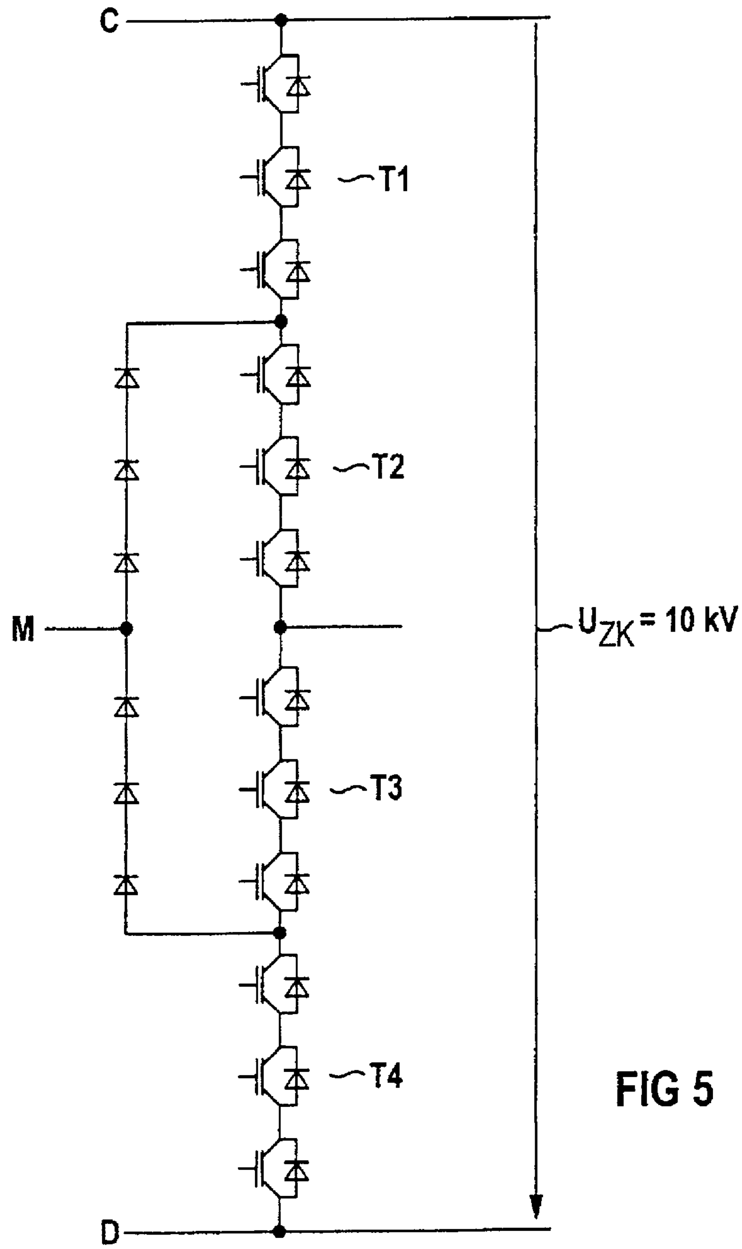

FIG 5

Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

As a below named inventor, I hereby declare that:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

My residence, post office address and citizenship are as stated below next to my name,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Spannungszwischenkreis-Umrichter

Indirect Voltage Converter

deren Beschreibung

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 07.06.2000 als
PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/DE00/01847
eingereicht wurde und am ________
abgeändert wurde (falls tatsächlich abgeändert).

the specification of which

(check one)
☐ is attached hereto.
☒ was filed on 07.06.2000 as
PCT international application
PCT Application No. PCT/DE00/01847
and was amended on ________
(if applicable)

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign appplications
Priorität beansprucht

Priority Claimed

19926979.3	DE	14.06.1999	☒	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35. United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occured between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/01847	07.06.2000	pending	
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D, M, Y) (Anmeldedatum T, M, J)	(Status) (patentiert, anhängig, aufgegeben)	(Status) (patented, pending, abandoned)
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D,M,Y) (Anmeldedatum T, M; J)	(Status) (patentiert, anhängig, aufgeben)	(Status) (patented, pending, abandoned)

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